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Population dynamic models based on individual energy budgets lead to counterintuitive fisheries predictions

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Abstract
Historically, models describing the dynamics and management of marine fish stocks are based on assumptions that poorly reflect the ecology of individual fish and the complex interactions among them and their environment. For example, the most often used multi-species fisheries models only take into account the negative effect of predator-prey relations between fish species, that is, the mortality impact of the prey, but ignore the benefits of this predation, the increase in mass of the predator. With an increasing demand for ecosystem based management of fish stocks this discrepancy between the models and the ecology becomes important to address. In this presentation I review how current fisheries models account for ecological processes. Subsequently, I will introduce a class of size-structured population models based on individual energetics that explicitly account for ecological interactions of individual fish. Analysis of models of this kind will be shown to not only increase our understanding of the mechanisms shaping fish community dynamics, but also make counterintuitive predictions about the outcome of fisheries management strategies. More specifically, it will be shown how intermediate levels of harvesting prey fish may promote rather than demote persistence of piscivores. Finally, I will show how these results crucially depend on explicitly accounting for maintenance costs, that is, the energetic costs of routine metabolism that individual fish have to cover for persistence.

Keywords: Size-structured population models, individual energetics, predator-prey interactions, population size-structure, ontogeny, food-dependent somatic growth.

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